Thermal Spray Coatings Explained: HVOF Process, Tungsten Carbide, and More

When it comes to surface restoration and extending the service life of high-wear components, few technologies are as versatile and effective as thermal spraying. At HFW Industries, we've been leading the field for over seven decades, applying state-of-the-art solutions like **high velocity oxy-fuel (HVOF)** to industries that demand precision, durability, and performance.

In this post, we'll walk through the fundamentals of thermal spray, dive deep into HVOF, compare it to hardfacing, explore different coating processes, and explain what types of materials can be coated and sprayed—with a special focus on **tungsten carbide**, **Stellite ® alloys, and cobalt-based alloys**. Contact our team to discuss how we can use our expertise to improve your operations.

What Is Thermal Spraying?

Thermal spraying is an umbrella term for a group of processes used **to deposit finely divided metallic, ceramic, or cermet materials onto a prepared surface**. These coatings are mechanically bonded—meaning the coating adheres by interlocking with the roughened surface rather than through melting or dilution into the base material. All thermal spray processes consist of a coating material (whether it be in wire, powder, or rod form), an energy or heat source, and a propellant to atomize the molten material and propel it to the substrate, resulting in a coating.

Key Benefits of Thermal Spraying:

- **Minimal part distortion:** Low application temperatures (typically below 300°F)
- **Customizable coatings:** Wide range of material options
- **Increased durability:** Extend component life with minimal downtime
- **Precise surface properties:** From anti-slip to RF shielding

HVOF: High Velocity, High Performance

High Velocity Oxy-Fuel (HVOF) is one of the most advanced thermal spray techniques in use today. In this process, powdered material—such as **tungsten carbide/cobalt or Stellite #6 alloys**—is heated in a high-pressure flame and propelled at supersonic speeds onto the surface. The result is an **extremely dense, hard, and low-porosity coating** that provides exceptional resistance to wear, heat, and corrosion.

Why Choose HVOF?

- **Very dense coatings** with minimal porosity
- **Chemical resistance** – Especially important in corrosive environments
- **Lower risk of hexavalent chromium exposure**
- **Precise control** over material characteristics and thickness
- **Ideal for finishing** – HVOF coatings can be ground or polished to extremely fine surface finishes

Popular HVOF materials include:

- **Tungsten carbide/cobalt** – excellent for abrasion and erosion resistance
- **Stellite #6 alloy** – a cobalt-based alloy ideal for wear and corrosion
- **Chromium carbide** – high-temperature oxidation resistance
- **Nickel-Chrome-Boron alloy** – great for hard, corrosion-resistant coatings
- **Hastelloy ® C, Inconel ® 625/718** – exceptional in chemical and heat environments

HVOF vs. Hardfacing: What's the Difference?

Thermal spraying—particularly HVOF—and hardfacing are two widely used methods for protecting industrial components, but they differ significantly in process and application. HVOF thermal spray **creates a mechanical bond** between the coating and substrate, typically applied at low temperatures (usually under 300 °F). This process does **not melt the base metal, resulting in no material dilution**, and it allows for coating finished parts without distortion. HVOF coatings are generally layered and porous, depending on process parameters. Common materials used in HVOF include **ceramics, carbides like tungsten carbide, and various metals**, making it ideal for precise, low-heat applications where wear, corrosion, or thermal resistance is critical.

In contrast, **hardfacing involves creating a metallurgical bond** by welding or fusing material directly to the base surface, which typically occurs at high temperatures. This results in **some dilution with the base metal, forming a homogenous alloy weld**. Hardfacing is most commonly performed with nickel-, cobalt-, or iron-based alloys, and it is better suited for **heavy-wear, high-heat, and structural applications** where durability and impact resistance are essential.

So, when is HVOF preferred? When you need **tight tolerances, fine finishes, and excellent surface performance** without altering the part's base structure. If you're restoring or enhancing rolls in galvanizing lines or high-speed rotating equipment, HVOF coatings with materials like tungsten carbide or Stellite alloys are ideal.

Thermal Spray Processes Explained

At HFW Industries, we offer a complete suite of thermal spray technologies to match your performance, geometry, and finishing needs.

Flame Spray (Wire & Powder Metallizing)

- Wire or powder feedstock melted by oxygen-fuel gas flame
- Compressed air propels the molten particles
- Ideal for restoration, dimensional build-up, and general wear resistance

Electric Arc Wire Spray

- Two wires arc electrically at the gun's tip
- Molten droplets atomized and sprayed with air
- Economical and fast, often used on large surfaces

Plasma Spray

- Ionized gas (plasma) melts the coating powder
- Powder propelled by kinetic energy to the substrate
- Excellent for ceramics, cermets, and high-melting-point metals

HVOF (High Velocity Oxy-Fuel)

- Extremely dense, high-velocity coatings
- Best for wear-critical and corrosion-resistant coatings
- Frequently uses tungsten carbide, Stellite alloys, chromium carbide, and more

Rokide ® Flame Spray (Ceramic Rod)

- Ceramic rods melted with oxy-fuel flame and sprayed with air
- Provides thermal insulation, electrical resistance, and corrosion protection
- HFW was the first commercial licensee of the Rokide process

Spray Welding (Thermal Spray + Fusing)

- Self-fluxing alloy powder sprayed onto surface
- Then fused to base metal via torch
- Results in metallurgically bonded, hard, and uniform overlay

What Materials Can Be Coated?

One of the chief advantages of thermal spraying is its versatility in what it can adhere to.

Easily Coated:

- Most metals under 50 Rc hardness
- Some non-metallic materials, depending on prep and temperature

Requiring More Technique:

- Highly oxidizing metals (like aluminum, copper, and titanium) require special process control to avoid contamination
- Very hard surfaces need special preparation (grit blasting, bonding layers) to ensure strong adhesion

At HFW, our team evaluates the **substrate composition, surface condition, and operating environment** to ensure coating success. We follow our high quality standards for prep, application, and testing.

Not Just Tungsten Carbide: A World of Materials

At HFW, we don't believe in a one-size-fits-all approach. The coating must match the application—and we use decades of experience to guide material selection.

Here are just a few of the thermal spray materials we regularly apply:

Carbides:

- Tungsten Carbide/Cobalt (WC/Co)
- Tungsten Carbide/Nickel
- Chromium Carbide/Nichrome

Metals & Alloys:

- Nickel/Chrome
- Hastelloy C
- Stainless Steel (T316, T420)
- Inconel 625, 718
- Monel, Copper, Molybdenum

Cobalt-based:

- Stellite #6 alloys
- Tribaloy ®

Ceramics & Cermets:

- Alumina, Zirconia, Chrome oxide, and more

Applications: Why and Where We Spray

Our customers can turn to us for thermal spraying for a wide range of performance goals:

- **Size restoration** of worn or mis-machined parts
- **Abrasion and erosion resistance**
- **Corrosion protection**, including in marine and chemical environments
- **Heat shielding or electrical insulation**
- **Anti-slip** or **anti-stick** surfaces
- **Radio frequency (RF) shielding** for sensitive components

And because many thermal spray coatings can be applied to finished or in-service parts, it's often a faster and more economical option than full part replacement.

Choosing the Right Process

At HFW Industries, we evaluate every project with a holistic lens, considering:

- **Operating conditions** (temperature, friction, corrosion)
- **Part geometry** and **surface access** (HVOF is line-of-sight only)
- **Desired coating properties** (thickness, finish, hardness)
- **Budget and downtime constraints**

We offer a full range of processes: flame spray (wire and powder), electric arc, Rokide ceramic spraying, plasma spray, spray welding, and of course, HVOF.

The Bottom Line

Thermal spraying—**especially HVOF**—has revolutionized the way industrial components are protected and restored. Whether you're dealing with abrasion, corrosion, or extreme heat, there's a material and process to match your needs. With tungsten carbide, Stellite alloys, and cobalt alloys in our toolbox and a commitment to high quality, HFW Industries is ready to help you achieve longer-lasting, better-performing components.

But what truly sets HFW apart is our ability to go beyond coatings and deliver full-service solutions for industrial equipment and components.

From thermal spraying and hardfacing weld overlays to CNC machining, precision grinding, finishing, and assembly, HFW offers a **comprehensive, one-source service model**—all under one roof in our Buffalo, NY, facility. Our team of industry-trained engineers and skilled tradespeople understands the technical and economic significance of your components, and we tailor our processes to your operational needs.

By combining these services, we help customers:

- **Reduce downtime and lead time**
- Eliminate multi-vendor coordination
- Shorten the supply chain
- Ensure quality from start to finish

This integrated approach has been the foundation of our success for more than 70 years.

At HFW, we are continually investing in new technologies and process improvements to deliver the best possible results at a fair price—whether you're in chemical processing, power generation, oil and gas, mining, or advanced manufacturing. **We don't just manufacture and recondition parts; we help extend their life, enhance their performance, and protect your investment.**

To see our equipment in action, visit our Photo Gallery for examples of how our one-source capabilities deliver real-world results. We encourage you to explore our comprehensive thermal spray services and check out our detailed blog posts on HVOF coatings and other related topics.

Looking for specialized services like EMRO (electrical mechanical runout) inspection? We've got that covered too. Whether you're building new or reconditioning old, your components are in the right hands at HFW.

Have a part that needs protection or repair? Contact us today or visit our website to see which coating or reconditioning system is right for your application.

📞 Call us at (716) 875-3380 or use our Contact Form
📧 Email: RFQ@hfwindustries.com

Want to explore more? **Start with these resources from our Knowledge Base:**

- What is Thermal Spraying? — A beginner-friendly overview of the process and materials used
- HVOF -- A Superior Alternative to Chrome — Why HVOF coatings often outperform chrome in durability, cost, and turnaround time
- How HFW Extends Equipment Life — Real-world example of innovation in action
- What is Electrical Mechanical Runout (EMRO)? — Learn how EMRO shaft inspection can help ensure operations run smoothly
- What are HFW's Hardfacing Capabilities? — Explore how HFW's hardfacing expertise restores industrial equipment with proven weld procedures and precision inspection

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